Mal J Nutr 16(1): 131-136, 2010

Proposed New Anthropometric Indices of Childhood Undernutrition

Kaushik Bose[1] **& Gopal Chandra Mandal**[1,2]

[1] *Department of Anthropology, Vidyasagar University, Midnapore, India*
[2] *Bangabasi College, Kolkata, India*

ABSTRACT

The three conventional anthropometric indicators of childhood undernutrition are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height). Recently a new composite index, namely the Composite Index of Anthropometric Failure (CIAF) has been proposed and utilised to study childhood undernutrition. In this paper, we have attempted to construct three new indices of undernutrition, relative to the CIAF. These three indices are: Stunting Index (SI) = Stunting / CIAF, Underweight Index (UI) = Underweight / CIAF and Wasting Index (WI) = Wasting / CIAF. Furthermore, we have calculated and compared these indices using our dataset as well as other existing datasets. Using our dataset, the sex-combined values of SI, UI and WI were 0.364, 0.866 and 0.684, respectively. The corresponding values among boys were 0.364, 0.866 and 0.729. Among girls, they were 0.380, 0.866 and 0.641, respectively. When applied to the all India dataset, the values of SI, UI and WI were 0.756, 0.788 and 0.266, respectively. Similar values (SI = 0.723, UI = 0.681, WI = 0.294) were observed when they were computed on data available from Coimbatore, South India. In conclusion, we suggest that these three new indices provide additional information on the prevalence of different forms of undernutrition relative to the total level of undernutrition in a particular population.

Keywords: Composite Index of Anthropometric Failure, Stunting Index, Underweight Index, Wasting Index

INTRODUCTION

Childhood undernutrition can be evaluated anthropometrically (Lee & Nieman, 2003; Bose *et al.*, 2007). The three most commonly used internationally recommended anthropometric indicators are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height) (WHO, 1995). While stunting (ST) reflects a failure to reach linear growth potential due to sub-optimal health and / or nutritional conditions, underweight (UW) reveals low body mass relative to chronological age, which is influenced by both, a child's height and weight. ST is an indicator of chronic undernutrition, the result of prolonged food deprivation and / or disease or illness. UW thus cannot distinguish between a child that is small in weight relative to his / her height and a child that is low in height relative to his / her age, but who may be normal in weight-for-height. On the other hand, wasting (WS) is an indicator of acute undernutrition, the result of more recent food deprivation or illness; UW is used as a

Correspondence author: Dr. Kaushik Bose; Email:*banda@vsnl.net*

composite indicator to reflect both acute and chronic undernutrition, although it cannot distinguish between them (WHO, 1995). However, because they overlap, none is able to provide a comprehensive estimate of the number of undernourished children in a population; some children who are ST will also have WS and / or be UW; some children who are UW will also have WS and / or be ST; and some children who have WS will also be ST and / or UW (Nandy *et al.*, 2005). Svedberg(2000), a development economist, argued that conventional indices are not sufficient for measuring the overall prevalence of undernutrition among young children. He suggested that if children with WS, ST or who are UW are all considered as undernourished, or to be in a state of *anthropometric failure*, a new aggregate indicator is needed, one that incorporates all undernourished children, be they WS and / or ST and / or UW and proposed the construction of a Composite Index of Anthropometric Failure (CIAF). Based on Svedberg's model, Nandy *et al.* (2005) had utilised the CIAF on Indian data and recommended its use in preference to the three conventional measures (ST, UW and WS) of undernutrition. Nandy & Miranda (2008) have further supported and validated the use of CIAF in a more recent paper.

However, a recent report has highlighted some shortcomings of CIAF (Bhattacharya, 2006). Moreover, although CIAF is an useful composite measure, it fails to highlight the individual contribution and importance of ST, UW and WS relative to the overall prevalence of undernutriton. In other words, if we want to know what are the rates of ST, UW and WS relative to the overall prevalence of undernutrition, we require three new indices. These new indices can also give us information on the relative significance and severity of these three measures with respect to the total prevalence of undernutrition.

The objective of our present study is to construct three new indices of childhood undernutrition. Furthermore, we have calculated and compared these indices using our dataset as well as other existing datasets.

METHODOLOGY

The present study was undertaken during the period November 2005 to December 2006 at 20 Integrated Child Development Services (ICDS) centres in Bali Gram Panchayet, Arambag, Hooghly District of West Bengal, India. The study area consists of remote villages located approximately 100 km. from Kolkata, the capital of West Bengal. A total of 1012 children (boys = 498; girls = 514) aged 2-6 years were measured. Age and ethnicity of the subjects were verified from official records. Height and weight measurements were taken on each subject by one author (GM) following the standard techniques by Lohman, Roche & Martorell (1988). Three commonly used undernutrition indicators, that is, ST, UW and WS as well as CIAF were used to evaluate the nutritional status of the subjects. Internationally accepted, the National Centre for Health Statistics (NCHS) (Hamill *et al.*, 1979; WHO, 1983) age and sex specific – 2 z-scores were followed to define ST, UW and WS.

Z-scores were calculated following the standard formula:

$$\text{Z-score} = \frac{\text{X} - \text{Median of NCHS}}{\text{Standard deviation of NCHS}}$$

Where X is an individual value, three Z-scores were calculated: HAZ = Height-for-age Z-score; WAZ = Weight-for-age Z-score; WHZ = Weight-for height Z-score

Based on WHO (1995), undernutrition was defined as follows:

Stunting: HAZ < - 2SD (standard deviation);
Underweight: WAZ < - 2SD;
Wasting: WHZ < - 2SD.

For assessing the CIAF, Svedberg's (2000) model of six groups (stunted only,

Table 1. Classification of children with anthropometric failure (CIAF)*

Group name	*Description*	*Wasting*	*Stunting*	*Underweight*
A	No failure	No	No	No
B	Wasting only	Yes	No	No
C	Wasting and underweight	Yes	No	Yes
D	Wasting, stunting & underweight	Yes	Yes	Yes
E	Stunting & underweight	No	Yes	Yes
F	Stunting only	No	Yes	No
Y	Underweight only	No	No	Yes

* Classification following Nandy *et al.* (2005).

under-weight only, wasted only, wasting and underweight, stunted and underweight and lastly stunted, wasted and underweight) of children was used. These groups include children with height and weight appropriate for their age (i.e., who are not in anthropometric failure) and also children whose height and weight for their age are below the norm and thus are experiencing one or more forms of anthropometric failure (Nandy *et al.*, 2005). These groups are defined in greater detail in Table 1. The CIAF excludes those children not in anthropometric failure (i.e., group A) and counts all children who have wasting, stunting, or are underweight (i.e., groups B to Y). It therefore provides a single measure with which to estimate the overall prevalence of undernutrition. Svedberg originally suggested six subgroups of anthropometric failure (A to F). However, Nandy *et al.* (2005) identified an additional subgroup: one that includes children who are only underweight but not stunted or wasted (group-Y). Another theoretical combination would be 'wasted and stunted', but this is not physically possible since a child cannot simultaneously experience stunting and wasting and be not underweight. The use of CIAF may have profound implications on prevalence reporting, nutrition programming and outcomes. Reporting of accurate prevalence data and targeting highest risk populations for appropriate interventions using CIAF may help to improve the quality and outcomes of global nutrition efforts (Berger *et al.*, 2006). Mahgoub (2009) is of the opinion that the use of CIAF methods more clearly identified risk levels with mutually exclusive categories to identify both prevalence and higher nutritional risk with multiple anthropometric failures. However, Bhattacharyya (2006) has explained its drawbacks too. According to him, it does not satisfy the long-felt need for a combined clinical and anthropometric classification that would be useful for clinical as well as community health work.

In this paper, we propose the use of three new indices of childhood undernutrition. These three indices are:

Stunting Index (SI) = Stunting / CIAF
Underweight Index (UI) = Underweight / CIAF
Wasting Index (WI) = Wasting / CIAF

These indices do not have any unit.

RESULTS

Table 2 presents the prevalence of ST, UW, WS and CIAF among the studied children. Results revealed that 26.6%, 63.3% and 50.0% were suffering from ST, UW and WS, respectively. The CIAF showed a higher prevalence of undernutrition with 73.1% of the studied children suffering from anthropometric failure (CIAF), in comparison to other three indicators (ST, UW and WS).

Table 2. Prevalence of undernutrition among the studied children aged 2-6 years

Category	*Age in years*					
	2 (n = 183)	*3 (n = 230)*	*4 (n = 241)*	*5 (n = 240)*	*6 (n = 118)*	*Total (n = 1012)*
Stunted	25.7%	26.4%	24.5%	27.6%	30.5%	26.6%
Underweight	65.5%	56.3%	63.5%	65.3%	69.5%	63.3%
Wasted	46.9%	48.1%	48.5%	57.7%	45.8%	50.0%
CIAF	75.9%	67.5%	72.6%	75.7%	75.4%	73.1%

Percentages are given in the parentheses. n = number of individuals.

Table 3. Values of SI, UI and WI among the studied children.

Index	*Boys CIAF = 358*	*Girls CIAF = 382*	*Overall (sex combined) CIAF = 740*
SI = Stunting / CIAF	124 / 358 = 0.346	145 / 382 = 0.380	269 / 740 = 0.364
UI = Underweight / CIAF	310 / 358 = 0.866	331 / 382 = 0.866	641 / 740 = 0.866
WI = Wasting / CIAF	261 / 358 = 0.729	245 / 382 = 0.641	506 / 740 = 0.684

Boys: ST = 124, UW = 310, WS = 261; Girls: ST = 145, UW = 331, WS = 245.
Overall sex-combined: ST = 269, UW = 641, WS = 506.

Table 3 presents the sex-specific as well as sex-combined values of the three new indices, SI, UI and WI. These sex-combined overall values of SI, UI and WI were 0.364, 0.866 and 0.684, respectively. The corresponding values among boys were 0.346, 0.866 and 0.729. Among girls they were 0.380, 0.866 and 0.641, respectively.

DISCUSSION

Traditionally, ST, UW and WS have been used as anthropometric indicators of undernutrition among children (Bhattacharya, 2000, Lee & Nieman, 2003; Bose *et al*. 2007). However, in studies evaluating childhood nutritional status, the CIAF has also been utilised and validated by investigations from Kenya (Berger, Hollenbeck & Fields-Gardner, 2006), South Asia and Sub-Saharan Africa (Harttgen & Misselhorn, 2006), China (Dang & Yan, 2007), India (Seetharaman *et al.*, 2007), Botswana (Mahgoub, Silo & Fields-Gardner, 2009) and Cameroon (Emina, 2009). Nevertheless, a recent report by Bhattacharya (2006) has highlighted some drawbacks of CIAF.

In this paper, we have attempted to construct three new indices of childhood undernutrition which deal with the problem of ST, UW and WS relative to the total prevalence of undernutrition. This is in contrast to the rates of ST, UW and WS which are absolute measures. The CIAF on the other hand indicates total undernutrition and does not provide any information on the prevalence of ST, UW and WS relative to total undernutrition. We feel that these three new indices, SI, UI and WI provide information on the significance of the problems of ST, UW and WS with respect to and relative to total undernutrition. We have calculated these indices on three datasets (Table 4) including ours. These values can also be interpreted as percentages. For

Table 4. Comparison of SI, UI and WI of different studies

Reference	*SI*	*UI*	*WI*
Nandy *et al.* (2005) n= 24,396	0.756	0.788	0.266
Seetharaman *et al.* (2007) n= 405	0.723	0.681	0.294
Our study n=1012	0.364	0.866	0.684

example, in Nandy *et al's* study (2005) the value of SI was 0.756. In other words, ST was observed in 75.6% of all cases of undernutrition. Similarly, in our study ST, UW and WS were observed in 36.4%, 86.6% and 68.4% of all cases of undernutrition, respectively. The obvious utility of these three new indices is that they inform us about the relative severity of ST, UW and WS with respect to total undernutrition in a population. The higher the value, the greater the severity with respect to total undernutrition. Moreover, in excluding normal individuals, these indices are undernutrition-specific.

There are several potential advantages in using these new anthropometric indices from the public health and primary health care perspectives. Effective health promotion and nutritional interventional programmes can be formulated based on these indices. For example, a higher value of SI would indicate enhanced level of chronic undernutrition relative to total undernutrition necessitating increased long-term nutritional intervention. Similarly, a higher value of UI would indicate greater level of current undernutrition requiring increased immediate intervention.

However, it must be pointed out that these three new indices cannot replace the conventional measures of undernutrition. Rather they should supplement them in order to get a more comprehensive picture of the nutritional stress being experienced by a population. It is not hypothised that these new indices are superior to the other anthropometric indicators of undernutrition. However, what we suggest is that they provide additional information on the prevalence of different forms of undernutrition ***relative*** to the total level of undernutrition in a particular population. Moreover, further studies using these new indices should be undertaken among children of different populations, particularly in rural areas of developing countries. Such investigations would generate a database of these indices for not only regional and international comparisons but also provide an insight into ethnic and socio-economic variations in different forms of undernutrition. Lastly, it should be noted that given the fundamental importance of undernutrition to child survival and health, these indices may be of vital use and have implications for policy makers and planners alike.

ACKNOWLEDGEMENTS

All subjects who participated in the study are gratefully acknowledged. Special thanks are due to the ICDS authorities of these centers. Gopal Chandra Mandal received financial assistance in the form of a Minor Research Project from the University Grants Commission, Government of India [PSW-046/03– 04 (ERO)].

REFERENCES

Berger M, Hollenbeck C & Fields-Gardner C (2006). Prevalence of malnutrition in HIV/AIDS Orphans in the Nyanza Province of Kenya: A comparison of Conventional Indices with a Composite Index of Anthropometric Failure (CIAF). *J Am Diet Assoc* 106: A20–A20.

Bhattacharya AK (2000). Assessment of growth and nutritional status in Indian population. *J Indian Anthropol Soc* 49: 69–102.

Bhattacharya AK (2006). Composite index of anthropometric failure (CIAF) classification: is it more useful? *Bull WHO* 86: 335.

Bose K, Biswas S, Bisai S, Ganguli S, Khatun A, Mukhopadhyay A & Bhadra M (2007). Stunting, underweight and wasting among Integrated Child Development Services (ICDS) scheme children aged 3-5 years of Chapra, Nadia District, West Bengal, India. *Matern Child Nutr* 16–221.

Dang SN & Yan H (2007): Optimistic factors affecting nutritional status among children during early childhood in rural areas of Western China. *Zhonghua Yu Fang Yi Xue Za Zhi* 41: 108–114.

Emina JBO (2009) Child malnutrition in Cameroon: Does out-of-wedlock childbearing matter ? Avalaible at website: *www.uclouvain.be/cps/ucl/doc/demo/documents/Enima.pdf* [accessed 15 Sept 2009].

Hamill PV, Drizd TA Johnson CL, Reed RB, Roche AF & Moore WM (1979). Physical growth: National Center for Health statistics percentiles. *Am J Clin Nutr* 32: 607–29.

Harttgen K & Misselhorn M (2006). A multilevel approach to explain child mortality and undernutrition in South Asia and Sub-Saharan Africa. Available at website: *www.opus.zbw-kiel.de/volltexte/2006/4743/pdf/Misselhorn.pdf* [accessed 15 Sept 2009].

Lee RD & Nieman DC. (2003). Nutritional Assessment. McGraw Hill, New York.

Lohman TG, Roche AF & Martorell R (1988). Anthropometric Standardization Reference Manual. Human Kinetics Books, Chicago.

Mahgoub S, Silo L & Fields-Gardner C (2009). Effect of Dietary protein Enrichment Pilot Program on the growth of under-five children in day care centres in Gaborone, Botswana. Available at website: *www.wishh.org/nutrition/botswana_daycare_vasps.pdf* [accessed 15 Sept 2009].

Nandy S M, Irving M, Gordon D, Subramanian SV & Davey Smith G (2005). Poverty, child undernutrition and morbidity: new evidence from India. *Bull World Health Organ* 83: 210–216.

Nandy S & Miranda JJ (2008). Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. *Soc Sci Med* 66: 1963–1966.

Seetharaman N, Chacko TV, Shankar SRL, Mathew AC (2007). Measuring malnutrition – the role of Z-scores and the Composite Index of Anthropometric Failure (CIAF). *Indian J Comm Med* 32: 35–9.

Svedberg P (2000). Poverty and Undernutrition; Theory, Measurement and Policy. Oxford India Paperbacks, New Delhi.

World Health Organization (1983). Measuring Change in Nutritional Status. World Health Organization, Geneva.

World Health Organization (1995). Physical Status: the Use and Interpretation of Anthropometry : Technical Report Series no. 854. World Health Organization, Geneva.